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(54) **Endoscopic surgical system with sensing means**

Endoskopisches chirurgisches System mit Sensormitteln

Système chirurgical endoscopique avec moyens de détection

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(73) Proprietor: **ETHICON INC.**
Somerville New Jersey 08876 (US)

(72) Inventor: **Hooven, Michael Dawson**
Cincinnati, Ohio 45241 (US)

(74) Representative:
Mercer, Christopher Paul et al
Carpmaels & Ransford
43, Bloomsbury Square
London WC1A 2RA (GB)

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Description

Filed of the Invention

[0001] This invention relates to a system for use in endoscopic procedures. More specifically, this invention relates to a system which will automatically sense physical properties of the tissue on which the procedure is being conducted and/or certain parameters of an endoscopic surgical instrument.

Background of the Invention

[0002] Endoscopic surgery has been gaining wide acceptance as an improved and cost effective technique for conducting certain surgical procedures. In endoscopic surgery, a trocar, which is a pointed piercing device, is sent into the body with a cannula placed around the trocar. After the trocar accomplishes piercing of the abdominal walls, it is removed and the cannula remains in the body. Through this cannula, endoscopic procedures are possible. Often multiple openings are produced in the body with a trocar so that an endoscopic instrument may be placed in one cannula, appropriate viewing mechanisms placed in another cannula and fiber optics for illuminating the surgical field placed in yet another cannula. Generally, these endoscopic procedures take place under insufflation. As more is learned about endoscopic procedures and more instruments developed, the type of procedures that may be performed endoscopically will increase. Presently, typical procedures are gall bladder removal, tissue repair and various sterilization procedures.

[0003] Broadly, the instruments used in surgery can be classified into two broad classes. One class is manipulation devices; that is, devices which will grasp tissue, position tissue, irrigate, apply suction, and the like. The second class may be termed active devices. Generally, these devices either cut or staple tissue and some devices may combine these actions. Examples of such devices are electrosurgery instruments, ultrasonic instruments, lasers, circular stapling instruments, linear stapling instruments, ligating and cutting instruments and the like.

[0004] While endoscopic surgical procedures have substantial benefits to the patient, they do present certain problems to the surgeon conducting the procedure. For example, because the active part of the instrument is further removed from the manipulative part of the instrument, any slight movement of that manipulative part is magnified when it reaches the active part. Hence, when placing and forming a staple in tissue, the hand of the surgeon must be a lot steadier during the endoscopic procedure than if that same procedure was done during standard open surgery. Another difficulty arises because the surgeon, conducting the procedure, cannot see the field in which he is operating in a direct manner but is watching that field on an appropriate video display and manipulating the instrument based on what he sees on that video display. Hence, in designing endoscopic surgical instruments, considerable effort is made to reduce the force required in order to operate the instrument and allow the surgeon to have greater control over the instrument. Also, from an engineering standpoint, considerable design engineering is required to permit function of the active portion of the instrument given the physical limits of force and stroke of the surgeon's hand. In view of this, a surgeon may chose an instrument having a limitation on its output since the surgeon will know that additional output would be excessive. For example, US-A-4705038 discloses an arthroscopic tissue cutting or abrading instrument. Alternative heads are provided for attaching to a power unit mounted within a handle portion. Each head is capable of different surgical procedures by virtue of its size and configuration. An indicator is provided on each head to distinguish one particular head from the others, and a sensor means provided in the handle portion reads the indicator so that the output of the power unit can be controlled dependant upon the head unit attached thereto.

[0005] Sensor means have also been provided in instruments to determine the status of the procedure. For example, EP-A-0121474 discloses an apparatus for surgical occluding and cutting that incorporates sensing means to ensure that a first step of a procedure is performed prior to allowing the next step to be performed. In this manner, incorrect surgical procedures can be prevented.

[0006] Another problem, particular to endoscopic procedures, is that the surgeon can no longer feel tissue with his hands to determine thickness, consistency, texture, etc. US-A-4742815 discloses an endoscope in which sensing means, linked to a computer, are provided. The limitations that the tissue possess are preset into the computer and if the surgeon exceeds these limitations an alarm sounds to warn the surgeon.

[0007] It should also be pointed out that for medical reasons it is often desirable to make endoscopic instruments disposable. A major reason for this is that small, intricate, reusable instruments are difficult to sterilise, and if you can make the instrument disposable these sterilisation problems are eliminated. However, making the instrument disposable will often increase the cost of the instrument and this cost must be balanced with the medical advantage. Another problem with endoscopic instruments is their access limitations; that is, the ability to manipulate the head of the instrument after it has been placed in the cannula is difficult and the scope of movement is limited.

Summary of the Invention

[0008] According to the present invention, there is provided an endoscopic instrument comprising an

endoscopic distal head portion for carrying out a step in an endoscopic surgical procedure, said step in an endoscopic procedure including tissue manipulation, clip applying, stapling, ligation, cutting or the combination of such steps; a shaft connected to and extending proximally from said head portion; means for applying a motion to said shaft; means disposed in said head portion for translating the motion applied to the shaft into a force and/or motion of the head portion to carry out the step in the procedure; sensing means; and control means adapted to control the force and/or motion of the head portion, said control means interconnected with said sensing means. The sensing means is disposed in said head portion and the sensing means is adapted to measure the force and/or motion of a predetermined part of said head portion.

[0009] The means for providing a motion to the instrument may be a DC motor, releasably connected to the instrument, and the system may include means for identifying said instrument type, detecting said identification and controlling use of the instrument according to said identification.

[0010] The means for providing a motion to the instrument may apply energy to the head portion either by or through the shaft.

[0011] The endoscopic surgical system of the present invention provides a system allowing for a high degree of control in the manipulation of the active part or business head of an endoscopic instrument. Furthermore, my new system may provide greater access for the head of an endoscopic instrument during the surgical procedure. My new endoscopic system allows for greater forces to be applied at the head of the instrument while maintaining that head under stable control during the surgical procedure. My new endoscopic system may be disposable and even when disposable, in certain designs, may provide considerable reduction in cost. My new system allows the surgeon to expend less energy during the surgical procedure thus providing for improved manipulation and control of the instrument during the procedure. My new endoscopic system provides sensing feedback to the surgeon to compensate for the loss of tactile feedback. In certain designs of my new endoscopic system, the surgeon is provided with considerable knowledge regarding the instrument. For example, the surgeon may be informed as to the position of the instrument in the procedure, the operation of the instrument; i.e., whether it is in a position to be activated and activated correctly and the like.

[0012] In preferred embodiments of the present invention, the shaft is encased in a housing and the motion is provided to the shaft; i.e., rotation, longitudinal movement, etc. Means are disposed in the head of the instrument, to translate the motion of the shaft into a suitable force and/or motion in the head to carry out a desired step in the procedure; i.e., to set and form staples or to ligate a vessel or to sever tissue and so forth. Also, disposed in the head portion is a sensing means which measures the energy, force, or the motion of the head portion. In some instances, the sensing means may measure one or more physical parameters of the tissue on which it is to work or of the surrounding tissue. Inter-connected with that sensing means is a means which controls the energy, force and/or the motion of that head portion.

[0013] The present invention will be more readily understood and described in the attached description of the drawings taken in conjunction with the description of the invention.

Brief Description of the Drawings

[0014]

Fig. 1 is a schematic view of an endoscopic surgical system of the present invention interconnected with a microprocessor/controller and a video display screen;

Fig. 2 is a perspective view of an endoscopic stapling and cutting system in accordance with the present invention;

Fig. 3 is a longitudinal cross-sectional view of the handle portion of one embodiment of an endoscopic stapling and cutting system of the present invention;

Fig. 4 is a detail of the gear reduction assembly.

Fig. 4a is a cross-sectional view taken along line A-A of Fig. 4;

Fig. 4b is a cross-sectional view taken along line B-B of Fig. 4;

Fig. 5 is a longitudinal cross-sectional view of the shaft of the system depicted in Fig. 2;

Fig. 6 is an enlarged longitudinal cross-sectional view of the active or business head of the system depicted in Fig. 2;

Fig. 7 is an enlarged longitudinal cross-sectional view of the head of the system depicted in Fig. 6 with the head in a closed position;

Fig. 8 is an enlarged longitudinal cross-sectional view of the head of the system depicted in Fig. 6 with the head in the position of firing staples;

Fig. 9 is an enlarged longitudinal cross-sectional view of the head of the system of Fig. 6 with the head in the closed position after firing the staples;

Fig. 10 is an enlarged longitudinal cross-sectional view of the head of the system depicted in Fig. 6 with the head in the open position after the staples have been fired;

Fig. 11 is a perspective view of another embodiment of an endoscopic system of the present invention useful in placing ligating clips;

Fig. 12 is a longitudinal cross-sectional view of the handle of the instrument depicted in Fig. 11;

Fig. 13 is an assembly view of the shaft portion of the system depicted in Fig. 11;

Figures 14, 15 and 16 are sequential plan view of a

clip placed in the head of the system depicted in Fig. 11 when the clips are open, closing and fully closed, respectively;

Fig. 17 is a longitudinal cross-sectional view of a head of a system of the present invention depicting sensing means for sensing properties in the surrounding environment;

Fig. 18 is a block diagram showing the interrelationship of the principal components of one embodiment of a system according to the present invention;

Fig. 19 is a block diagram depicting a possible set of hardware architecture for a system of the present invention; and

Fig. 20 is a simplified flow diagram of one possible flow for the control logic for a system according to the present invention.

Detailed Description of the Invention

[0015] Referring to the drawings, there is shown in Fig. 1 a perspective view of an endoscopic system according to the present invention. In this Figure an endoscopic stapling and cutting instrument 30 is interconnected with a controller 31 and a video display monitor 32. The controller includes a microprocessor, power supply, hard-wired logic, sensor interface and motor drive circuits. The instrument is connected to the controller so that the controller can accept, store, manipulate, and present data. The controller may feed appropriate signals back to the instrument in order to operate the instrument. The controller also acts to supply power to the instrument at the appropriate level, frequency, timing, etc. Within the controller may be several hard-wired logic circuits controlling critical instrument functions. Also, several sensing circuits may be incorporated in the controller to measure voltage, current, power etc. The controller may also include a display screen to present the data it has received from the instrument and manipulate it in a desired way.

[0016] In Fig. 2 there is shown a perspective view of the endoscopic instrument depicted in Fig. 1. The instrument has a handle portion 40. Extending from this handle portion is a shaft portion 41 and at the end of the shaft portion is a desired head or business portion 42 of the instrument. The head or business portion is that portion of the instrument which accomplishes a step in a surgical procedure, whether that be ligating, stapling, cutting, manipulating tissue, or combinations of such steps. The head and shaft portions of the instrument are constructed so that they can be applied through the cannula of a trocar as is well known in endoscopy.

[0017] In the embodiment depicted in Figs. 2 through 9, the head portion is a linear stapler and cutter; that is, the head portion will place down plural parallel rows of staples with the staples offset in the rows. The instrument will also operate a knife to pass between two adjacent parallel rows of staples. Such an instrument staples tissue together and cuts that tissue between the stapled portions. Such instruments are used in various types of surgical procedures such as bowel and lung resections.

[0018] Fig. 3 is an enlarged, longitudinal cross-sectional view of the handle portion of the instrument depicted in Fig. 2. In this embodiment, the handle portion includes a small DC motor 45 attached to a gear box 46. Extending from the gear box is a rotatable drive shaft. The rotatable drive shaft extends substantially the length of the handle. Also included in the handle and interconnected with the DC motor are a suitable on-off switch 48 and a switch 49 to control the power supply being provided by the motor. A video display switch may also be provided in the handle if desired. While in this embodiment the motor itself is included in the handle, it should be appreciated that the motor could be separate from the instrument with appropriate connections so that a variety of instruments could be used with detachable motor or power source. Also, if the instrument is to be interconnected with a controller to accept, store and manipulate data, the motor may be connected to such controller and information such as current input, power output, voltage and other parameters may be monitored by the controller for manipulation, display, and use in a suitable manner.

[0019] As depicted in the cross-sectional views in Figs. 4, 4a and 4b, the motor shaft 50 extends into the center of the gear box 46. The gear box comprises two sets of gears 51 and 52, which reduce the rotation of the shaft 47 with respect to the motor at a ratio of 36:1 or other reduction as desired.

[0020] Referring to Fig. 5, there is shown an enlarged, longitudinal cross-sectional view of the shaft portion of the instrument shown in Fig. 2. In this embodiment, the shaft housing 60 is flexible. Through the center of the housing there extends the rotating, axially flexible, torsionally stiff shaft 61. The housing connects the handle of the instrument to the head of the instrument and the flexible shaft is connected to the drive shaft 47.

[0021] Figs. 6 through 10 are enlarged, longitudinal cross-sectional views of the head portion of the instrument depicted in Fig. 2. The views depict the head of the instrument in the open position prior to being placed on tissue (Fig. 6), in the closed position ready for firing (Fig. 7), during the firing action (Fig. 8), after the firing action has been completed (Fig. 9) and in the final open position (Fig. 10) when the instrument may be removed. In these figures, like parts are identified with the same numerals. The housing 70 of the head is suitably connected to the shaft housing 60 either by a press fit or ultrasonic welding or other similar means. Extending substantially the length of the head and connected to the rotating shaft 61 is a threaded rod 71. The threaded rod has a larger diameter portion 72 adjacent the shaft 61 and a smaller diameter portion 73 for the remainder of the threaded rod. The head includes a staple or sta-

ple cartridge portion 74 and an anvil portion 75. The staple portion and the anvil portion are pivotally connected to each other by the anvil pivot pin 76. Mounted on the larger diameter portion of the threaded rod is a closure nut and extending from that closure nut 77 is a closure pin 78 which moves in a slot 79 disposed in the pivotally mounted anvil portion of the head. When the flexible shaft is rotated, the threaded rod is also rotated and on rotating the closure nut will move down the threaded rod and move the closure pin in the closure slot to close the anvil portion against the staple portion of the head of the instrument. Tissue to be treated or manipulated is placed between the anvil portion and the staple portion of the head of the instrument when in the open position. Power is applied to the flexible shaft to rotate the shaft and the threaded rod and close the anvil portion. As can be appreciated, the amount of torque required to pivot the anvil portion about the pivot pin can be sensed and the thickness of tissue between the anvil and the staple portion determined. It is a simple matter for a controller to manipulate this information and inform the surgeon as to whether or not he has the appropriate amount of tissue between the anvil portion and the staple portion of the head of the instrument upon closure or whether he has too much or too little tissue and should re-manipulate the instrument. For a constant voltage drive, the force required to close the instrument may be measured by monitoring motor current. The power delivered to the instrument may be controlled by varying motor voltage and/or current to achieve a constant motor speed with varying load.

[0022] Mounted in the staple holding portion of the instrument is a removable staple cartridge 80. The cartridge holds four rows of staples 81. The rows are parallel and in adjacent rows the staples are off-set as is well known in the art. The cartridge is placed so that it is opposite the anvil portion of the instrument and snaps into the staple holding portion of the instrument as shown. As depicted in the figures, extending the length of the staple portion of the instrument is the smaller diameter portion of the threaded rod. Mounted on this rod, to move along the rod as the rod rotates, is a knife member 82 and a driving wedge member 83 which are inner-connected. The wedge member precedes the knife member as they move along the threaded rod. As the wedge member moves down the threaded rod, it drives the staples out of the cartridge, via the individual staple drivers 84. The staples pass through the tissue and against the anvil to form the staples in the tissue. The knife 82 following the driving wedge cuts the tissue between adjacent rows of staples. The driving wedge is actually two pieces; that is, it has one wedge piece on one side of the knife to drive the staples on that side of the knife and a like wedge piece on the opposite side of the knife to drive the staples on that side of the knife.

[0023] When the anvil portion 75 is closed as shown in Fig. 7, the closure nut 77 moves a stop member 85 forward so that the firing nut 86 on which the knife 82 and wedges 83 are disposed is moved forward and engages the threads of the smaller diameter portion 73 of the threaded rod to move forward along the rod and drive the staples 81 and cut tissue. The firing nut 86 is biased, using a suitable means, so as not to engage the threaded rod until a stop member 85 is activated. Once the firing nut has moved to its most forward position to drive and form all of the staples and cut the tissue, it engages a suitable contact 87 which immediately reverses the motor to retract the firing nut. In its fully retracted position, the firing nut 86 moves the stop member 85 rearwardly causing the closure nut 77 to then retract and open the anvil portion 75 of the head of the instrument. Another configuration would be to locate contacts in the handle portion of the instrument and use a follower nut on the rotating shaft to monitor position. It should be pointed out that it is desirable to locate as many as possible of the contacts and sensors in the handle portion of the instrument so that the head or business end can be maintained as small as possible and still accomplish the desired step in a procedure. By maintaining the head and shaft of the instrument as small as possible, the opening in the patient required for inserting the instrument may be kept small, thus increasing some of the benefits of an endoscopic procedure. As can be appreciated, various information may be transmitted during the operation of the instrument; for example, the movement of the stop member pushing the firing nut to the threaded rod for movement can be sensed. The most forward position of the wedges and knife may be sensed. The reversal of the motor may also be sensed as well as the movement of the stop member to open the anvil portion etc. Furthermore, if desired the presence of a cartridge and the presence of staples in that cartridge may also be sensed. All of this information may be fed back to a controller and stored and manipulated in the control unit so that the surgeon using the instrument will instantaneously receive information as to the placement of the staples, the cutting of the tissue, the presence of staples in the cartridge, etc.

[0024] Referring to Figs. 11 through 16, there is depicted an endoscopic ligating system of the present invention. The ligator comprises a handle portion 80 having appropriate on-off 81 and power control 82 switches. A hollow circular casing 83 extends from the handle portion and a clip applying head portion 84 is disposed at the opposite end of the circular casing. As more clearly shown in Fig. 12, in the handle portion is a rotatable drive shaft 85. One end of the drive shaft at the rear of the handle includes a connection 86 so that it can be connected to a DC motor or other suitable power means. The opposite end of the drive shaft is threaded 87. The threaded portion of the drive shaft engages a threaded end 88 of a longitudinally moveable rod 89. The rod is connected to longitudinally extending shaft 90. The shaft extends substantially the full length of the instrument from the handle to the head or business end of the instrument. When the drive shaft 87 is rotated, the

rod 89 and longitudinally extending shaft 90 move forward and when the rotation of the drive shaft is reversed, the rod and longitudinal extending shaft is retracted.

[0025] As shown in Fig. 13, the longitudinally extending shaft is mounted in a suitable support tube 115. The shaft comprises a longitudinally moveable cam channel 112, an enclosing member 113, a floor 110 opposite the enclosing member, a feed bar 99, an end cap 114, and a track 98 for holding ligating clips. Attached within the cam channel are the jaws 111 of the instrument. In operation, when the cam channel is moved forwardly, it encloses the jaws and brings them together to close a clip which has been placed in the jaws. When the drive shaft 87 is reversed, the channel retracts and the jaws opens. Also included in the shaft are a magazine or a stack of clips 97 held in track 98. The track also holds a feeder spring 94, lock lever 95 and feed shoe 96. The clips are positioned in the path of the feed bar 99 by spring 94. A lifter spring 93 is held in place over clip track 98 by shroud 92 and acts to place the first clip of the magazine into the plane of the feed bar for position in the jaws. The operation of this portion of the instrument can best be seen in Figs. 14, 15, and 16. As the cam channel 112 is urged forwardly, it engages the outer surface of the jaws 111 and pushes them towards each other to close the clip 120 about tissue 121. When the cam channel retracts, the jaws open. The clip magazine 97 is advanced forwardly and another clip is placed within the jaws. This happens when the spring 94 is released and the feed shoe advances the next clip from the stack of clips, which has been positioned in the path of the feed shoe by the spring so that another clip may be placed. Suitable sensing members 123 and 124 in the jaws can determine whether or not there is an appropriate clip in the jaws, whether or not the clip is appropriately closed and when the stack of clips is empty. All of this information may be fed back to a controller for storage and manipulation and appropriate information reported to the operator of the instrument.

[0026] While I have described my new system with specific reference to a linear stapler-cutter instrument and a ligating clip applier, it of course, can be used with other endoscopic instruments. For example, my new system could be used to control an electro-cauterizing instrument. My new system could be used to control the activation of such an instrument as well as the irrigation and suction used with cauterizing instruments.

[0027] In all of the previous embodiments, the sensing mechanism has been used to sense the operation of the instrument and to sense whether or not appropriate tissue is in the appropriate position, etc. It should be appreciated that the instruments may also be designed to sense physical parameters of the surrounding environment. For example, they may sense the blood oxygen content or tissue density of adjacent tissue or various hemostasis characteristics of adjacent tissue and the like may be used.

[0028] In Fig. 17, there is depicted the head of an instrument which includes a sensing member used to sense the blood oxygen content of adjacent tissue. In this embodiment, the instrument is a linear stapling instrument though other instruments are also meant to be encompassed in this embodiment. Figure 17 depicts the head or business end 160 of such an instrument. The head comprises a staple or staple cartridge holding member 161 and a pivotally mounted anvil member 162 similar to that depicted and described in conjunction with Figure 6. A light emitting diode (LED) 163 and phototransistor receiver 164 are disposed in the staple holding member. The transistor receiver comprises one or more photo-transistors and appropriate resistors. When tissue to be manipulated is placed between the staple member and the anvil member an electrical pulse is applied to the LED to cause light to be emitted by the LED. The emitted light contacts the tissue and, depending on the properties of the tissue, a portion of the light is reflected from the tissue to the photo-transistor thereby creating an electrical signal in direct proportion to the received optical signal. The amount of light striking the phototransistor may be measured and correlated to a desired property of the tissue such as oxygen content. The indirect measurement of tissue penetration via an opto-electronic signal conversion is used to control desired operations of the instrument. The operations that might be controlled would be the opening and closing of the anvil member and/or the firing of the staples. This is accomplished by feeding the light measurement to a controller which would in turn control the power source used to operate the instrument. Also, this information could be supplied to the surgeon via a video display. The surgeon could use this information to determine proper positioning of the instrument or other procedure related manipulations.

[0029] Fig. 18 portrays in a simple block diagram one form of a system according to the present invention. In this embodiment the endoscopic instrument is a stapler and cutter 200. The status of the instrument and various messages are communicated to the user by an interface with an endoscopic video camera 201 and monitor system 202. The system also includes an instrument microprocessor/controller 203. The endoscopic instrument is powered by a DC motor 204 and is connected to the controller by a cable 205. The controller is microprocessor based and includes circuits for sensing, motor control, sensor interface, video interface and power supply. The instrument includes miniature sensors to detect the power and/or force being used and limit switches and contacts to turn the motor on and off at predetermined positions. Limit switches are also used to detect various interlocks used in the instrument. The instrument may also include sensors to determine the position of the anvil to the cartridge and whether or not staples are present in the cartridge. All sensors, switches, and motors are connected to the controller via

the interface cable 205. This information, fed into the appropriate controller, is stored and manipulated and fed to a central processing communication system. Some information will be processed directly through the hard wired circuits. It is important to note that it is desirable to incorporate critical instrument functions in to the hard-wired logic of the controller whenever possible. The controller then may be used for non-critical functions and information processing. The processed and manipulated information is fed to a video display screen and/or a suitable written or audio display mechanism. The information may also be fed back to the instrument controller to control some or all of the instrument functions.

[0030] In Fig. 19 there is depicted a configuration of hardware that could be used in the system of the present invention. From the sensor input from the specific endoscopic instrument used, the control logic can make decisions and/or actions on things such as tissue compression, position and proximity, electrical properties, chemical properties, temperature etc.

[0031] The control logic may be based on analog computing, gate array logic, hard-wired combinational logic, or sequential embedded microprocessor control, etc. or even some combination of electrical, mechanical, hydraulic or pneumatic logic.

[0032] Fig. 20 is a simplified flow diagram for the control logic set forth above and described in conjunction with Figures 18 and 19.

[0033] It should now be evident that there has been described herein an improved endoscopic system that embodies a high degree of control and reliability while expanding the scope of the actions that can be accomplished by any specific instrument to provide improved endoscopic procedures.

[0034] Although the invention has been described by way of examples of preferred embodiments, it will be evident that other adaptations and modifications may be employed without departing from the spirit and scope of the invention.

Claims

1. An endoscopic instrument (30) comprising:

   an endoscopic distal head portion (42) for carrying out a step in an endoscopic surgical procedure, said step in an endoscopic procedure including tissue manipulation, clip applying, stapling, ligation, cutting or the combination of such steps;
   a shaft (41) connected to and extending proximally from said head portion (42);
   means for applying a motion to said shaft (41);
   means disposed in said head portion (42) for translating the motion applied to the shaft (41) into a force and/or motion of the head portion (42) to carry out the step in the procedure;
   sensing means; and
   control means adapted to control the force and/or motion of the head portion (42), said control means interconnected with said sensing means;
   characterised in that:
   the sensing means is disposed in said head portion (42) and the sensing means is adapted to measure the force and/or motion of a predetermined part of said head portion (42).

2. An instrument according to claim 1, wherein the means for applying motion to the shaft is a D.C. motor.

3. An instrument according to claim 1 or 2, wherein the D.C. motor is releasably connected to the instrument.

4. An instrument according to any of claims 1 to 3, including means for identifying said instrument (30) type, detecting said identification and controlling use of the instrument (30) according to said identification.

5. An instrument according to any preceding claim, which includes sensing means for determining at least one property of the tissue held by the instrument.

6. An instrument according to claim 7, in which the measured property is tissue thickness.

7. An instrument according to any preceding claim, wherein the instrument (30) farther comprises a handle portion (40), at least part of the shaft (41) is rotatable, the shaft (41) is connected to the handle portion (40), and the means for providing a motion (31) rotates the at least part of the shaft (41).

8. An instrument according to any preceding claim, wherein the instrument (30) applies staples to tissue held by the instrument (30) during the step in the procedure, the means for providing a motion (31) to the instrument is used to drive the staples into the tissue, and the sensing means determines the presence or absence of staples in the instrument (30).

9. An instrument according to any preceding claim, wherein the instrument (30) includes a knife (82) for severing tissue held by the instrument during the step in the procedure, the means for providing a motion (31) to the instrument operates the knife (82) to sever tissue held by the instrument (30), and the sensing means determines the position of the knife (82) in the instrument (30).

10. An instrument according to any preceding claim, wherein the instrument is a cutting and stapling instrument and the head portion (42) comprises a staple holding member (74) and an anvil member (75) pivotally connected at said staple holding member (74).

11. An instrument according to claim 10, which includes sensing means disposed in said head portion for detecting the presence or absence of staples in said staple holding member (74).

12. An instrument according to any of claims 1 to 7, wherein the instrument applies a plurality of clips used to ligate vessels during the step in the procedure.

13. An instrument according to claim 12, wherein the head portion comprises a pair of opposing jaws (111) for holding a clip.

14. An instrument according to claim 13, wherein a sensing means is disposed in the head portion (42) to detect when the jaws (111) are open or closed.

15. An instrument according to claim 13 or 14, wherein the head portion (42) comprises a sensing means to detect whether or not there is a clip in the jaws (111).

16. An instrument according to any one of claims 12 to 15, wherein the means for providing a motion to the instrument closes a clip about the vessel.

17. An instrument according to any of claims 1 to 11, wherein the head portion (42) comprises means for holding a cartridge of staples (74), a firing means for ejecting staples from said cartridge, anvil means (75) to form said staples, the anvil means (75) being disposed in relationship to the head portion to allow tissue to be disposed between the head portion (42), and the anvil means (75), a converting means is disposed at one end of the shaft, and connecting the firing means to the shaft, to convert the motion of the shaft into a force to eject staples from the cartridge and to form the staples in the tissue, a sensing means for determining the force required to eject and form the staples, and control means to control the ejection and formation of the staples.

18. An instrument according to any of claims 10, 11 or 17, wherein a sensing means is disposed in the head portion of the instrument (30) to detect at least one property of tissue placed between the head portion (42) and the anvil portion (75).

19. An instrument according to claims 17 and 18, wherein the anvil means (75) is pivotally connected to the means for holding a cartridge of staples at one end thereof.

20. An instrument according to claim 17 or 19, wherein the cartridge of staples contains at least two parallel rows of staples.

21. An instrument according to claim 20, wherein the head portion (30) includes cutting means reciprocally movable between the two rows of staples.

22. An instrument according to any one of claims 17, 19, 20 or 21, which includes a third sensing means disposed in the instrument for measuring a physical property of the instrument.

23. An instrument according to claim 21, wherein the cutting means comprises a knife (82) and the converting means also converts motion of the shaft into a force to move said knife (82).

24. An instrument according to claim 21, which includes a sensing means disposed in the instrument for determining the position of the knife (82).

Patentansprüche

1. Endoskopisches Instrument (30) mit:

einem endoskopischen distalen Kopfteil (42) zur Ausführung eines Schrittes bei einem endoskopischen chirurgischen Eingriff, wobei dieser Schritt eines endoskopischen Eingriffes die Handhabung von Gewebe, das Anbringen von Klemmen, das Klammern, das Abbinden, das Schneiden oder Kombinationen solcher Aktivitäten umfassen kann;
einem an diesem Kopfteil (42) angebrachten Schaft (41), der sich von dort in proximaler Richtung erstreckt;
einer Einrichtung zum Übertragen einer Bewegung auf den Schaft (41);
einer im Kopfteil (42) angeordneten Einrichtung zur Umsetzung der auf den Schaft (41) übertragenen Bewegung in eine Kraft und/oder Bewegung des Kopfteiles (42), um den Schritt des Eingriffes durchzuführen;
eine Sensoreinrichtung und
eine Steuereinrichtung zum Steuern der Kraft und/oder der Bewegung des Kopfteiles (42), wobei die Steuereinrichtung mit der Sensoreinrichtung in Verbindung steht;
dadurch gekennzeichnet, daß:
die Sensoreinrichtung im Kopfteil (42) angeordnet und derart eingerichtet ist, das sie die Kraft und/oder die Bewegung eines vorbestimmten Teiles des Kopfteiles (42) zu messen vermag.

2. Instrument nach Anspruch 1, bei welchem die Einrichtung zum Übertragen einer Bewegung auf den Schaft (41) ein Gleichstrommotor ist.

3. Instrument nach Anspruch 1 oder 2, bei welchem der Gleichstrommotor lösbar am Instrument angebracht ist.

4. Instrument nach einem der Ansprüche 1 bis 3, welches eine Einrichtung zur Identifikation des Typs des Instrumentes (30), zur Feststellung der Identifikation sowie zur Steuerung der Verwendung des Instrumentes (30) entsprechend der Identifikation aufweist.

5. Instrument nach einem der bisherigen Ansprüche, welches eine Sensoreinrichtung zur Bestimmung mindestens einer Eigenschaft des von dem Instrument gehaltenen Gewebes aufweist.

6. Instrument nach Anspruch 5, bei welchem die gemessene Eigenschaft die Dicke des Gewebes ist.

7. Instrument nach einem der bisherigen Ansprüche, bei welchem das Instrument (30) weiterhin einen Handgriff (40) aufweist, zumindest ein Teil des Schaftes (41) drehbar ist und der Schaft (41) am Handgriff (40) angebracht ist, wobei die Einrichtung (31) zum Übertragen einer Bewegung zumindest den letztgenannten Teil des Schaftes (41) dreht.

8. Instrument nach einem der bisherigen Ansprüche, bei welchem das Instrument (30) in dem von ihm gehaltenen Gewebe während eines Schrittes des Eingriffes Klammern anbringt, wobei die Einrichtung (31) zum Übertragen einer Bewegung auf das Instrument dazu verwendet wird, Klammern in das Gewebe einzudrücken und die Sensoreinrichtung die Anwesenheit oder Abwesenheit von Klammern im Instrument (30) feststellt.

9. Instrument nach einem der bisherigen Ansprüche, bei welchem das Instrument (30) ein Messer (82) zum Trennen des vom Instrument gehaltenen Gewebes während eines Schrittes des Eingriffes aufweist, wobei die Einrichtung (31) zum Übertragen einer Bewegung auf das Instrument das Messer (82) betätigt, um das vom Instrument (30) gehaltene Gewebe zu trennen und die Sensoreinrichtung die Position des Messers (82) im Instrument (30) feststellt.

10. Instrument nach einem der bisherigen Ansprüche, welches ein Schneid- und Klammerinstrument ist und der Kopfteil (42) eine Klammer-Halteeinrichtung (74) und einen Amboß (75) unfaßt, der schwenkbar an der Klammer-Halteeinrichtung (74) angebracht ist.

11. Instrument nach Anspruch 10, welches eine im Kopfteil angeordnete Sensoreinrichtung zur Feststellung der Anwesenheit oder Abwesenheit von Klammern in der Klammer-Halteeinrichtung (74) aufweist.

12. Instrument nach einem der Ansprüche 1 bis 7, welches eine Vielzahl von Klemmen anbringt, um während des Schrittes des Eingriffes Gefäße abzubinden.

13. Instrument nach Anspruch 12, bei welchem der Kopfteil ein Paar einander gegenüberliegender Klemmbacken (111) zum Halten einer Klemme enthält.

14. Instrument nach Anspruch 13, bei welchem im Kopfteil (42) eine Sensoreinrichtung angeordnet ist, um festzustellen, ob die Klemmbacken (111) geöffnet oder geschlossen sind.

15. Instrument nach Anspruch 13 oder 14, bei welchem der Kopfteil (42) eine Sensoreinrichtung enthält, um festzustellen, ob sich eine Klemme zwischen den Klemmbacken (111) befindet oder nicht.

16. Instrument nach einem der Ansprüche 12 bis 15, bei welchem die Einrichtung zum Übertragen einer Bewegung auf das Instrument eine Klemme um das Gefäß schließt.

17. Instrument nach einem der Ansprüche 1 bis 11, bei welchem der Kopfteil (42) ein Klammermagazin (74), eine Auslöseeinrichtung zum Ausstoßen von Klammern aus dem Magazin und einen Amboß (75) zum Formen der Klammern aufweist, wobei der Amboß in Bezug zum Kopfteil derart angeordnet ist, daß Gewebe zwischen dem Kopfteil (42) und dem Amboß (75) angeordnet werden kann, sowie weiterhin an einem Ende des Schaftes eine Umwandlungseinrichtung angeordnet ist, welche die Anslöseeinrichtung mit dem Schaft verbindet, um die Bewegung des Schaftes in eine Kraft zum Ansstoßen von Klammern aus dem Magazin und zum Formen derselben im Gewebe umzuwandeln und das Instrument weiterhin eine Sensoreinrichtung zur Bestimmung der zum Ansstoßen und zum Formen der Klammern erforderlichen Kraft und eine Steuereinrichtung zum Steuern des Ausstoßens und des Formens der Klammern umfaßt.

18. Instrument nach einem der Ansprüche 10, 11 oder 17, bei welchem eine Sensoreinrichtung im Kopfteil (30) des Instrumentes angeordnet ist, um mindestens eine Eigenschaft des zwischen dem Kopfteil (42) und dem Amboß (75) angeordneten Gewebes

festzustellen.

19. Instrument nach einem der Ansprüche 17 oder 18, bei welchem der Amboß (75) schwenkbar an einem Ende der Einrichtung zum Halten des Klammermagazins angebracht ist.

20. Instrument nach einem der Ansprüche 17 oder 19, bei welchem das Klammermagazin zwei parallele Reihen von Klammern enthält.

21. Instrument nach Anspruch 20, bei welchem der Kopfteil (30) eine zwischen den beiden Reihen von Klammern hin- und herbewegliche Schneideinrichtung aufweist.

22. Instrument nach einem der Ansprüche 17, 19, 20 oder 21, welches eine dritte Sensoreinrichtung zur Messung einer physikalischen Eingenschaft des Instrumentes aufweist.

23. Instrument nach Anspruch 21, bei welchem die Schneideinrichtung ein Messer (82) ist und die Umwandlungseinrichtung die Bewegung des Schaftes in eine Kraft zum Bewegen des Messers (82) umwandelt.

24. Instrument nach Anspruch 21, welches eine in diesem angeordnete Sensoreinrichtung zur Bestimmung der Position des Messers (82) aufweist.

Revendications

1. Instrument endoscopique (30) comportant :

   une partie de tête endoscopique distale (42) pour effectuer une étape d'un processus de chirurgie endoscopique, ladite étape du processus endoscopique comportant la manipulation, l'application d'une pince, l'agrafage, la ligature, la découpe d'un tissu ou la combinaison de telles étapes,
   un arbre (41) relié à ladite partie de tête (42) et s'étendant de manière proximale à partir de celle-ci,
   des moyens pour donner un mouvement audit arbre (41),
   des moyens disposés dans ladite partie de tête (42) pour transformer le mouvement donné à l'arbre (41) en une force et/ou un mouvement de la partie de tête (42) pour effectuer l'étape du processus,
   des moyens de détection, et
   des moyens de commande adaptés pour commander la force et/ou le mouvement de la partie de tête (42), lesdits moyens de commande étant reliés mutuellement auxdits moyens de détection,

   caractérisé en ce que :

   les moyens de détection sont disposés dans ladite partie de tête (42) et les moyens de détection sont adaptés pour mesurer la force et/ou le mouvement d'une partie prédéterminée de ladite partie de tête (42).

2. Instrument selon la revendication 1, dans lequel les moyens pour donner un mouvement à l'arbre sont constitués d'un moteur à courant continu.

3. Instrument selon la revendication 1 ou 2, dans lequel le moteur à courant continu est relié de manière libérable à l'instrument.

4. Instrument selon l'une quelconque des revendications 1 à 3, comportant des moyens pour identifier ledit type d'instrument (30), détecter ladite identification et commander l'utilisation de l'instrument (30) en fonction de ladite identification.

5. Instrument selon l'une quelconque des revendications précédentes, qui comporte des moyens de détection pour déterminer au moins une Propriété du tissu maintenu par l'instrument.

6. Instrument selon la revendication 7, dans lequel la propriété mesurée est l'épaisseur du tissu.

7. Instrument selon l'une quelconque des revendications précédentes, dans lequel l'instrument (30) comporte en outre une partie de poignée (40), au moins une partie de l'arbre (41) étant rotative, l'arbre (41) étant relié à la partie de poignée (40) et les moyens pour donner un mouvement (31) mettent en rotation ladite au moins une partie de l'arbre (41).

8. Instrument selon l'une quelconque des revendications précédentes, dans lequel l'instrument (30) applique des agrafes sur un tissu maintenu par l'instrument (30) pendant l'étape du processus, les moyens pour donner un mouvement (31) à l'instrument sont utilisés pour entraîner des agrafes à l'intérieur du tissu, et les moyens de détection déterminent la présence ou l'absence d'agrafes dans l'instrument (30).

9. Instrument selon l'une quelconque des revendications précédentes, dans lequel l'instrument (30) comporte un couteau (82) pour couper un tissu maintenu par l'instrument pendant l'étape du processus, les moyens pour donner un mouvement (31) à l'instrument actionnant le couteau (82) pour couper le tissu maintenu par l'instrument (30), et les moyens de détection déterminent la position du couteau (82) dans l'instrument (30).

10. Instrument selon l'une quelconque des revendications précédentes, dans lequel l'instrument est un instrument de découpe ou d'agrafage et la partie de tête (42) comporte un élément de support d'agrafes (74) et un élément formant enclume (75) relié de manière pivotante audit élément de support d'agrafes (74).

11. Instrument selon la revendication 10, qui comporte des moyens de détection disposés dans ladite partie de tête pour détecter la présence ou l'absence d'agrafes dans ledit élément de support d'agrafes (74).

12. Instrument selon l'une quelconque des revendications 1 à 7, dans lequel l'instrument applique plusieurs attaches utilisées pour ligaturer des vaisseaux pendant l'étape du processus.

13. Instrument selon la revendication 12, dans lequel la partie de tête comporte deux mâchoires opposées (111) destinées à supporter une attache.

14. Instrument selon la revendication 13, dans lequel des moyens de détection sont disposés dans la partie de tête (42) pour détecter lorsque les mâchoires (111) sont ouvertes ou fermées.

15. Instrument selon la revendication 13 ou 14, dans lequel la partie de tête (42) comporte des moyens de détection pour détecter si oui ou non il existe une attache dans les mâchoires (111).

16. Instrument selon l'une quelconque des revendications 12 à 15, dans lequel les moyens pour donner un mouvement à l'instrument ferment une attache autour du vaisseau.

17. Instrument selon l'une quelconque des revendications 1 à 11, dans lequel la partie de tête (42) comporte des moyens pour supporter une cartouche d'agrafes (74), des moyens de déclenchement pour éjecter des agrafes à partir de ladite cartouche, des moyens formant enclume (75) pour mettre en forme lesdites agrafes, les moyens formant enclume (75) étant disposés dans une disposition par rapport à la partie de tête qui permet au tissu d'être disposé entre la partie de tête (42) et les moyens formant enclume (75), des moyens de conversion disposés à une extrémité de l'arbre et reliant les moyens de déclenchement à l'arbre, pour convertir le mouvement de l'arbre en une force destinée à éjecter les agrafes de la cartouche et à former les agrafes dans le tissu, des moyens de détection pour déterminer la force requise pour éjecter et mettre en forme les agrafes, et des moyens de commande pour commander l'éjection et la mise en forme des agrafes.

18. Instrument selon l'une quelconque des revendications 10, 11 ou 17, dans lequel des moyens de détection sont disposés dans la partie de tête de l'instrument (30) pour détecter au moins une propriété du tissu placé entre la partie de tête (42) et la partie d'enclume (75).

19. Instrument selon les revendications 17 et 18, dans lequel les moyens formant enclume (75) sont reliés de manière pivotante aux moyens destinés à supporter une cartouche d'agrafes, à une extrémité de ceux-ci.

20. Instrument selon la revendication 17 ou 19, dans lequel la cartouche d'agrafes contient au moins deux rangées parallèles d'agrafes.

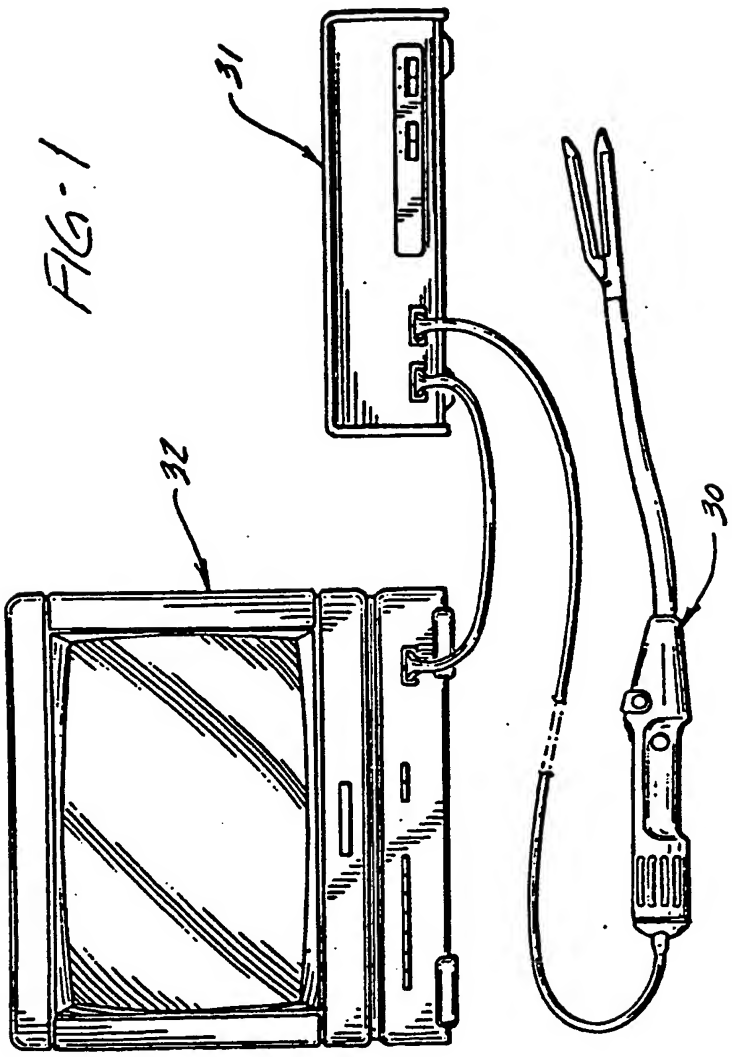
21. Instrument selon la revendication 20, dans lequel la partie de tête (30) comporte des moyens de découpe mobiles en va-et-vient entre les deux rangées d'agrafes.

22. Instrument selon l'une quelconque des revendications 17, 19, 20 ou 21, qui comporte des troisièmes moyens de détection disposés dans l'instrument pour mesurer une propriété physique de l'instrument.

23. Instrument selon la revendication 21, dans lequel les moyens de découpe comportent un couteau (82) et les moyens de conversion convertissent aussi le mouvement de l'arbre en une force pour déplacer ledit couteau (82).

24. Instrument selon la revendication 21, qui comporte des moyens de détection disposés dans l'instrument pour déterminer la position du couteau (82).

FIG. 1



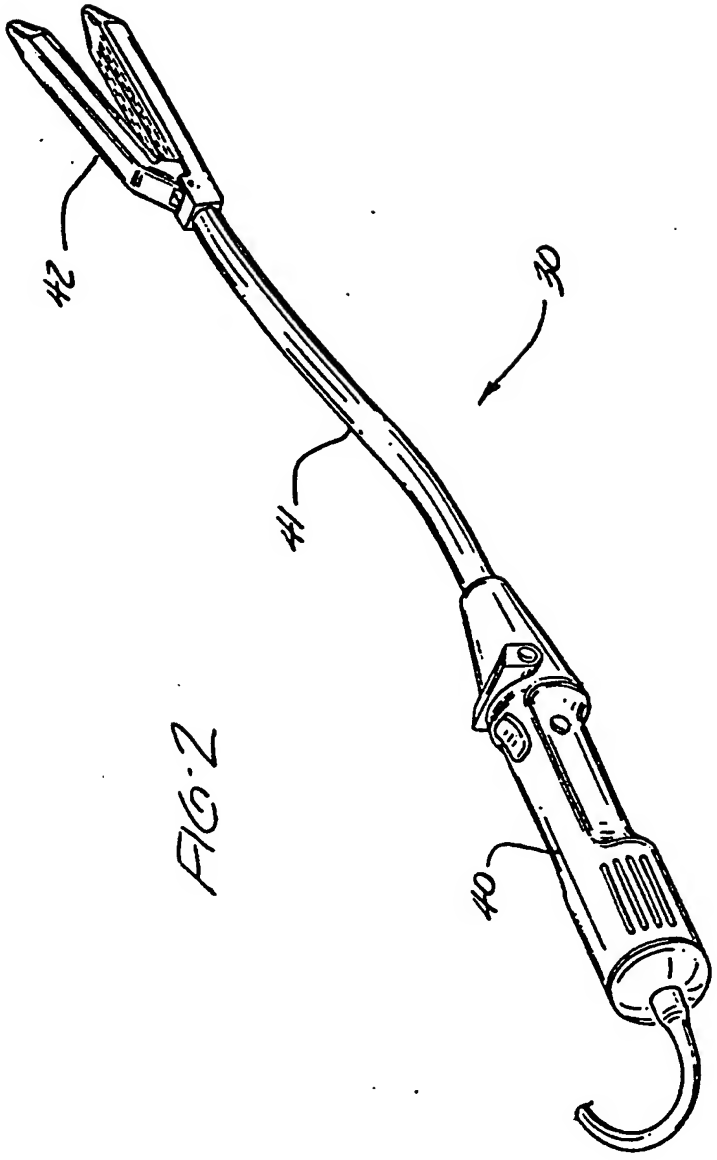


FIG.2

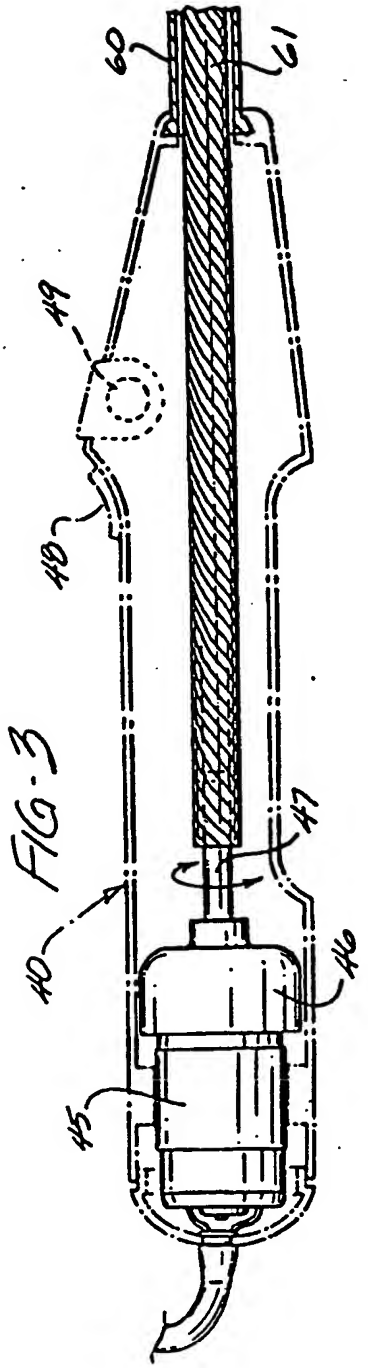


FIG-3

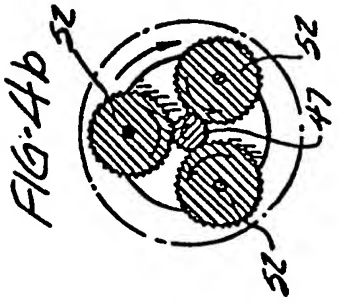


FIG-4b

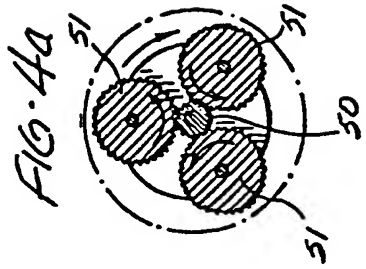


FIG-4a

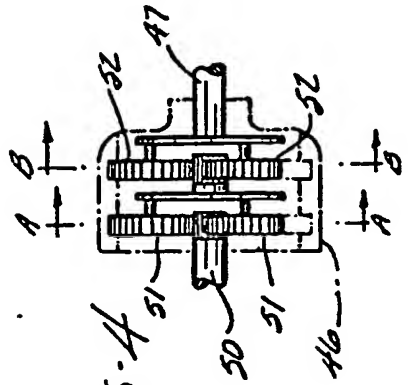


FIG-4

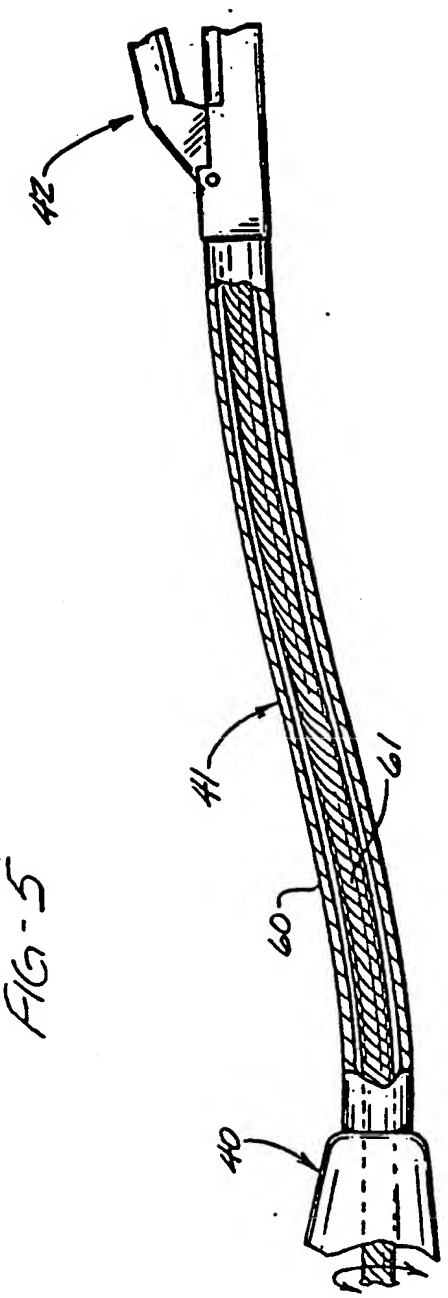


FIG-5

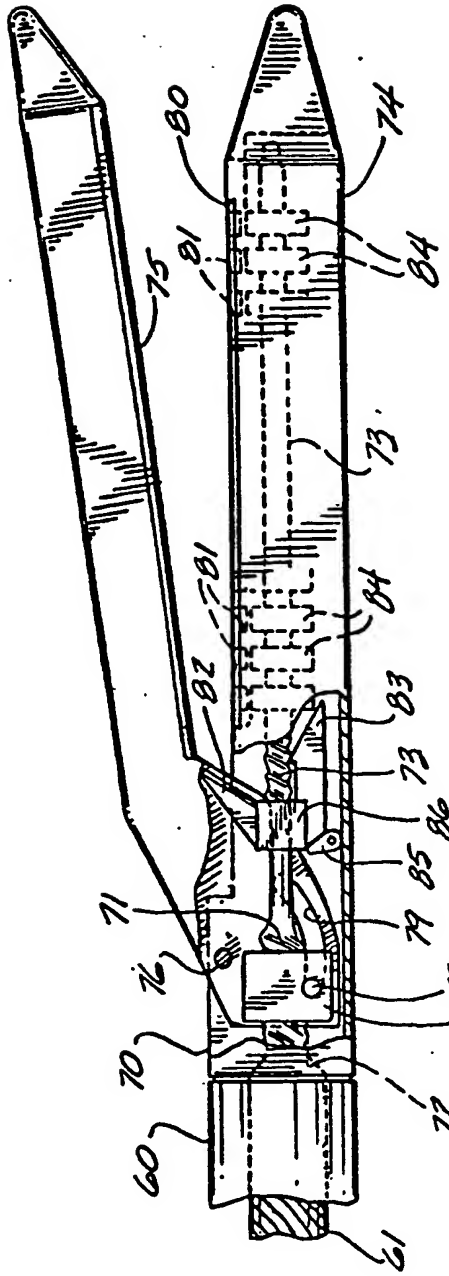


FIG. 6

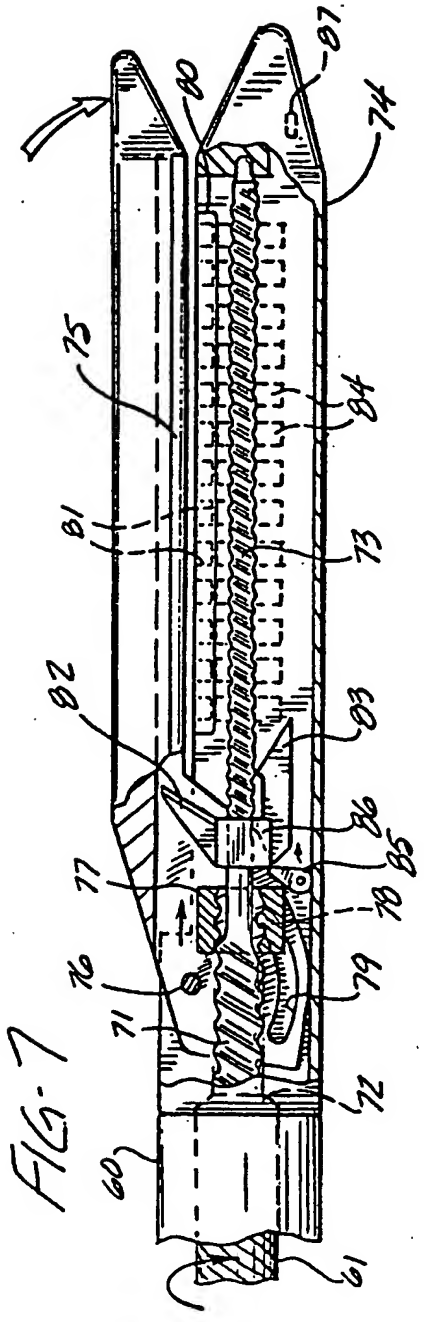

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FIG-7

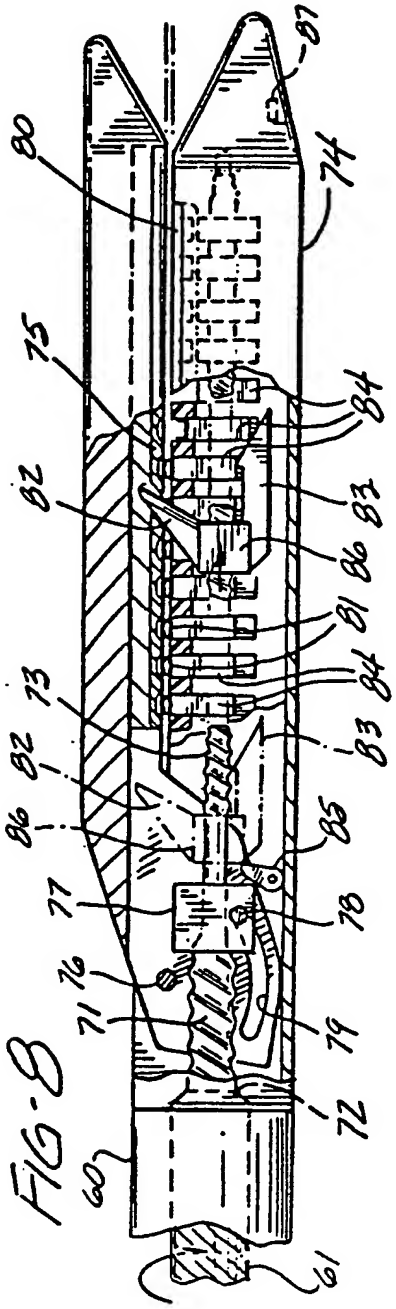
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FIG-8

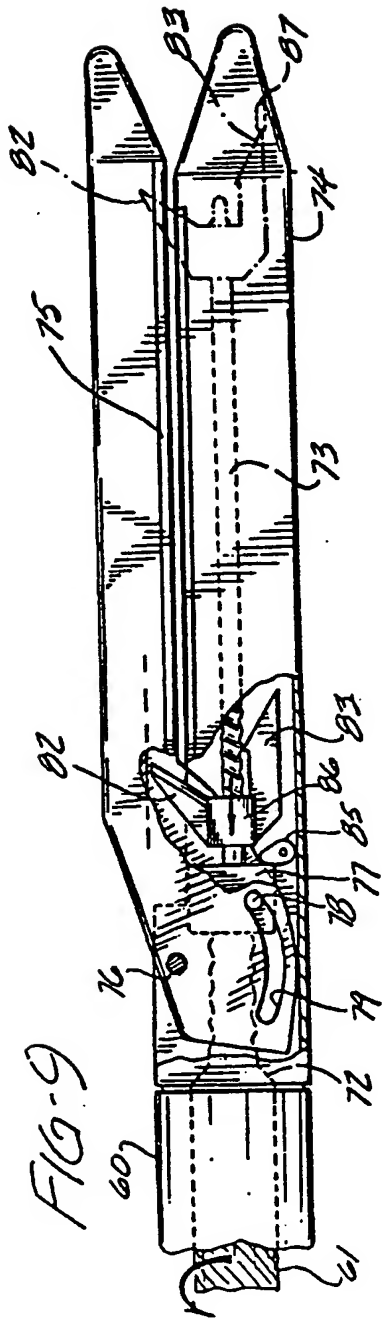
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FIG-9

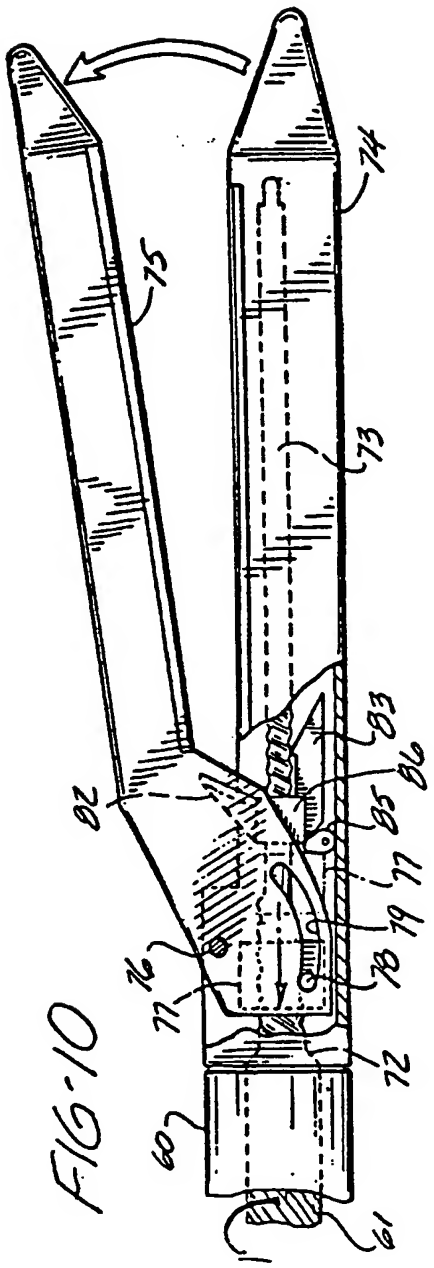
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FIG-10

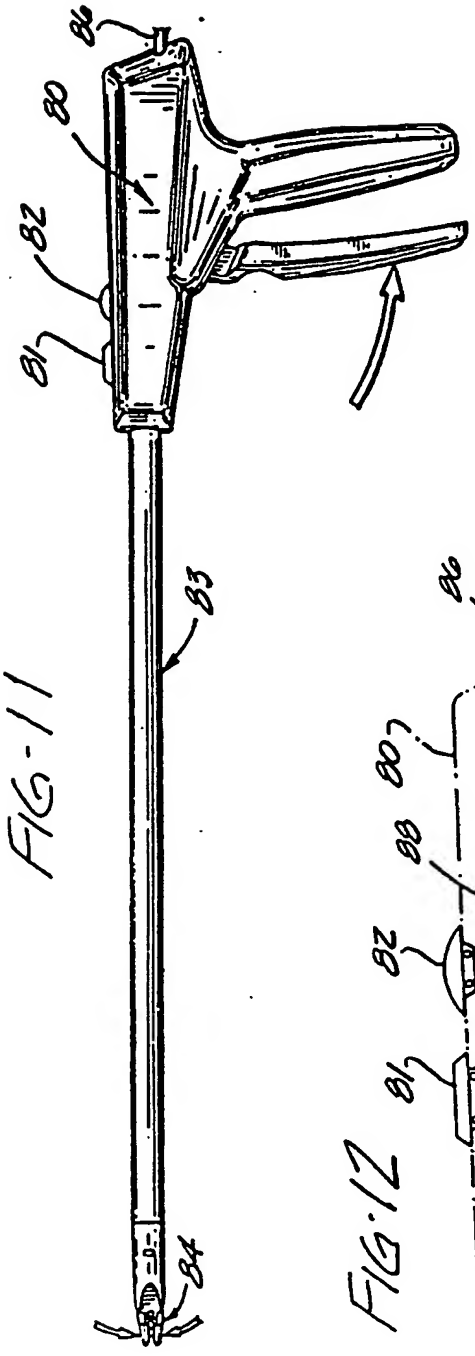


FIG-11

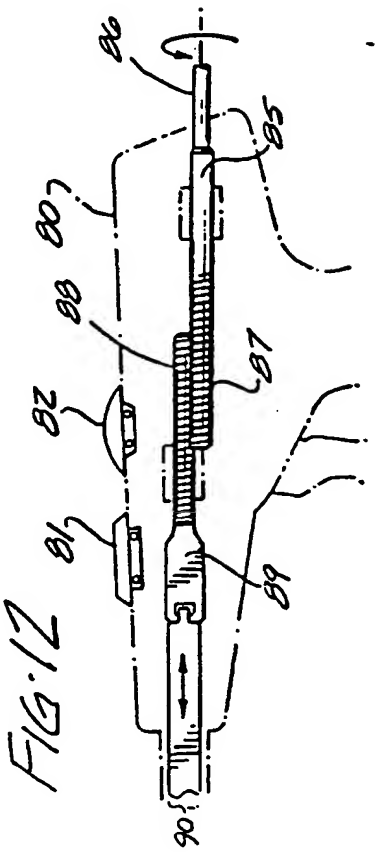


FIG-12

FIG-13

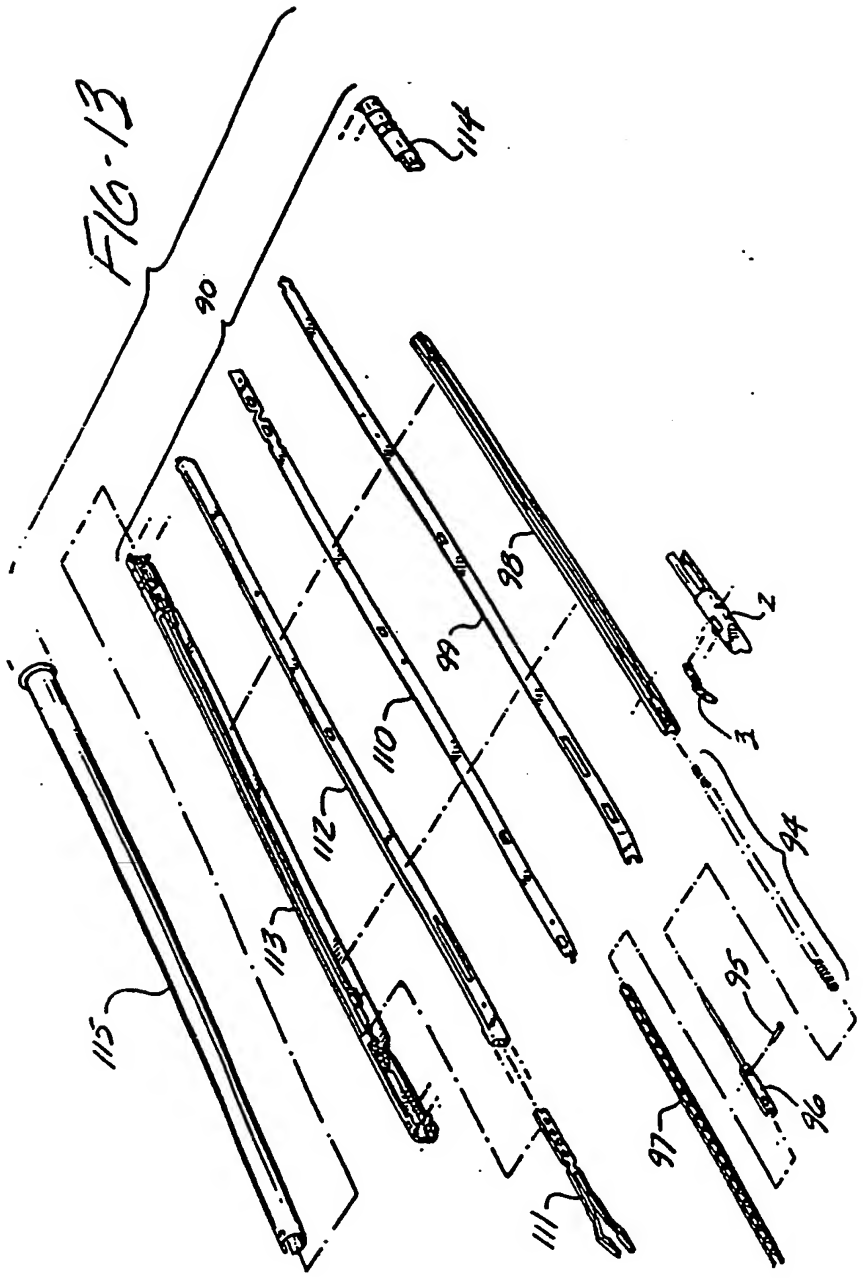


FIG-14

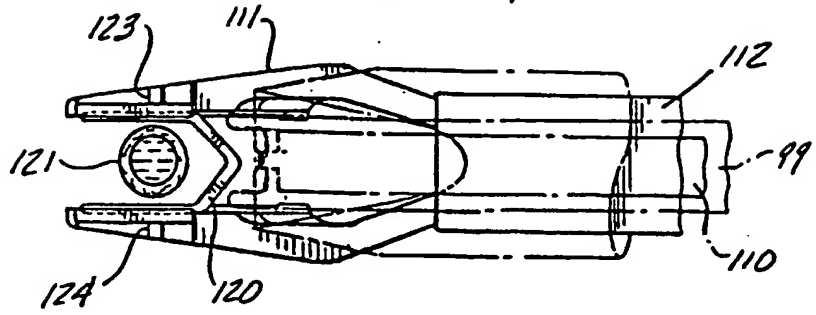


FIG-15

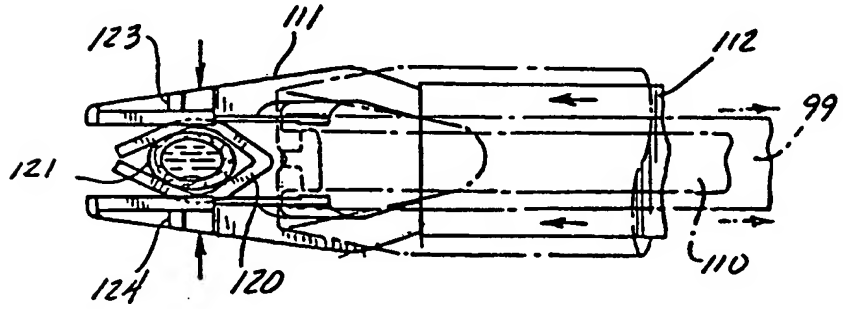
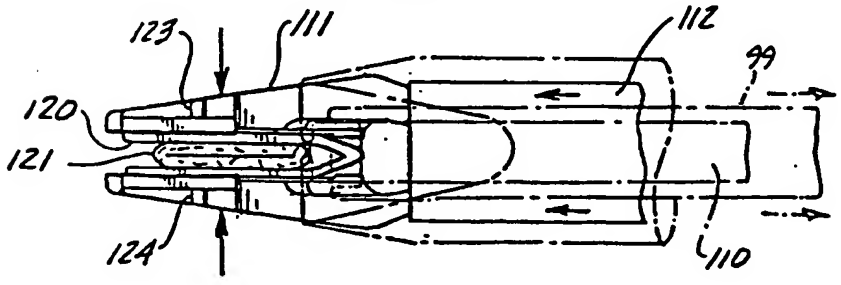


FIG-16



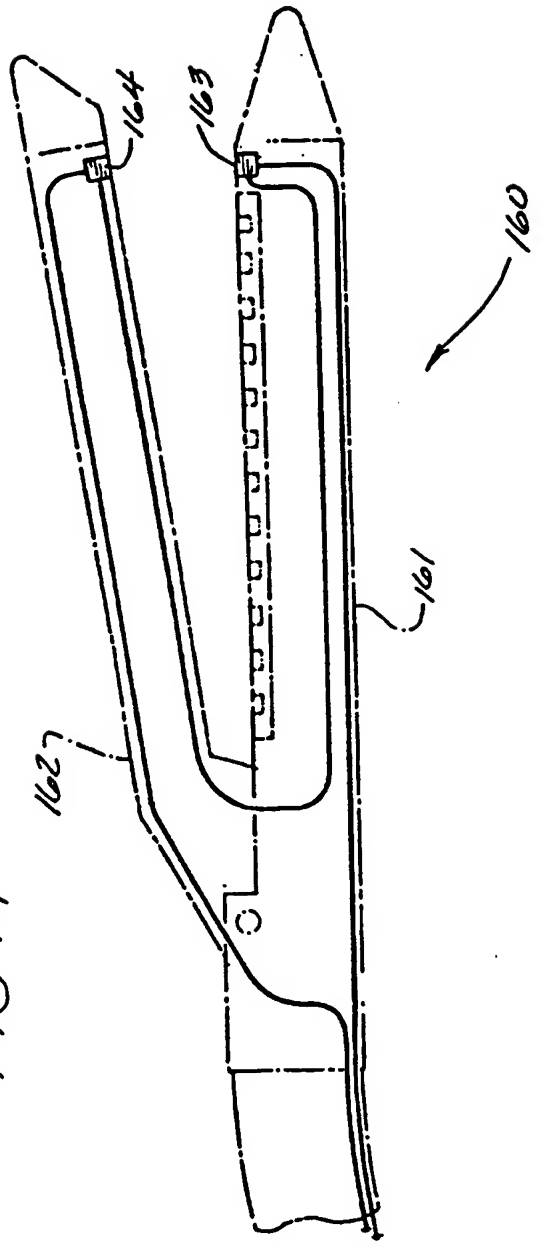


FIG-17

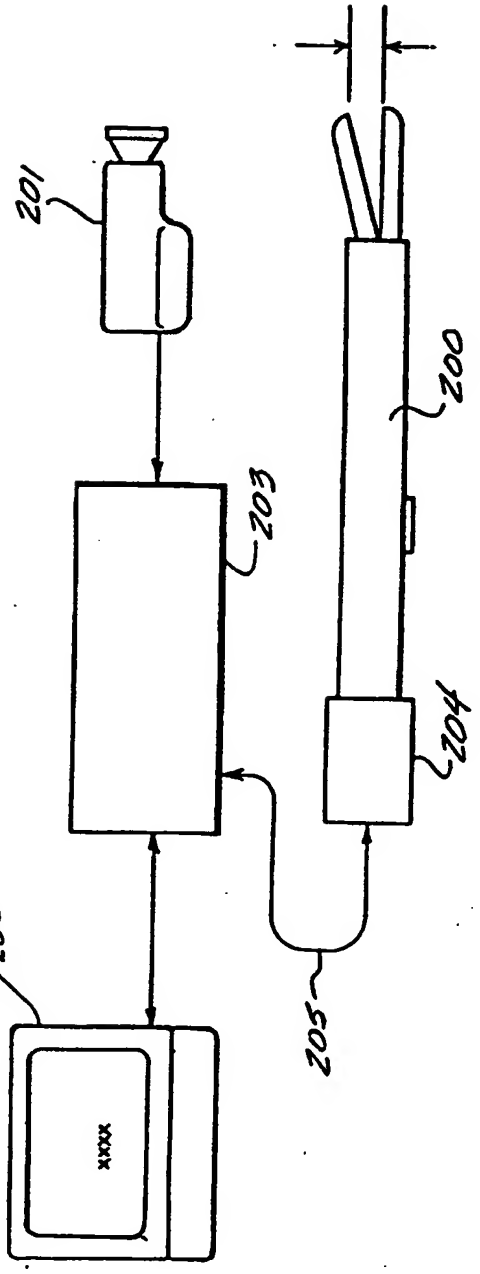


FIG - 18

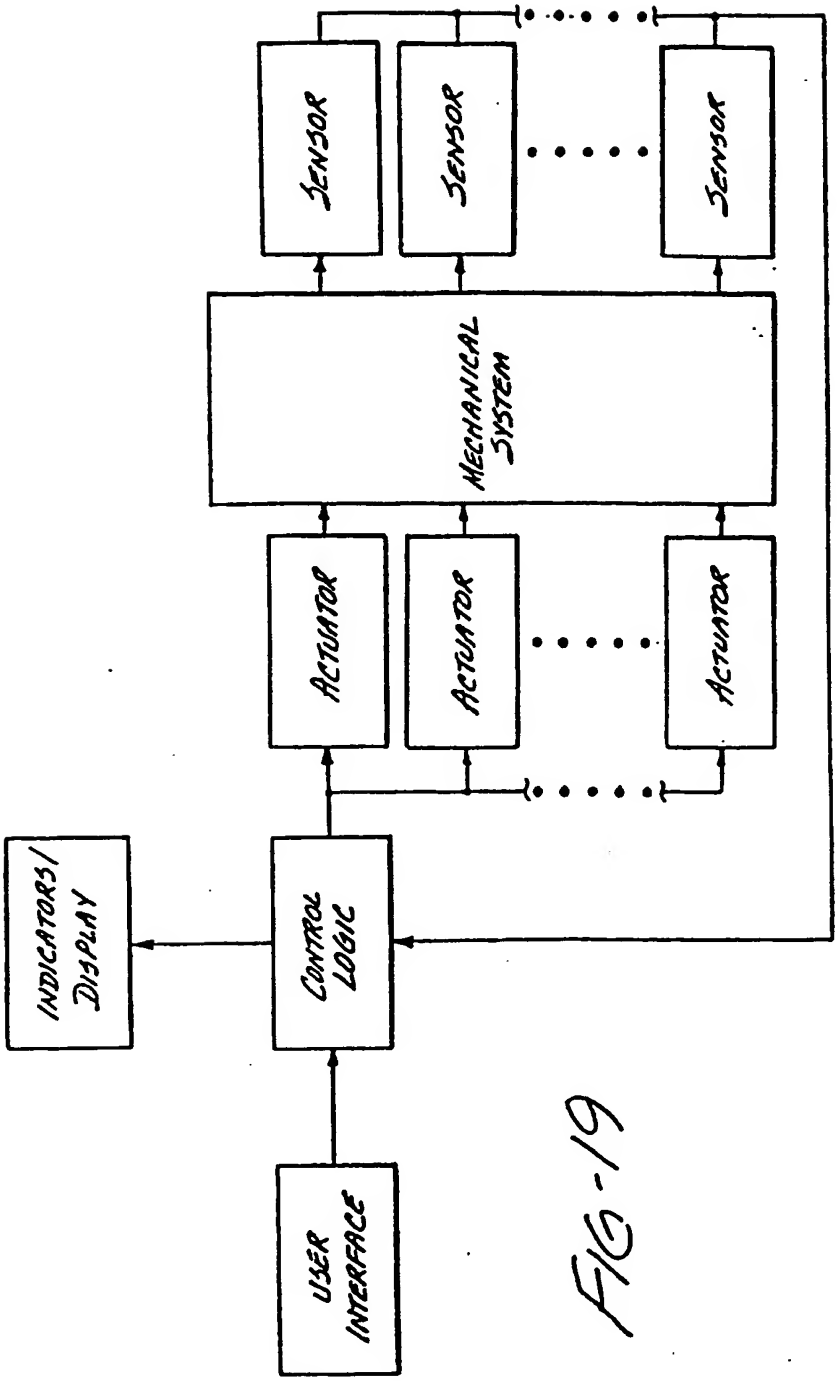

SENSOR
SENSOR
SENSOR
MECHANICAL SYSTEM
ACTUATOR
ACTUATOR
ACTUATOR
INDICATORS/ DISPLAY
CONTROL LOGIC
USER INTERFACE

FIG-19

FIG-20A

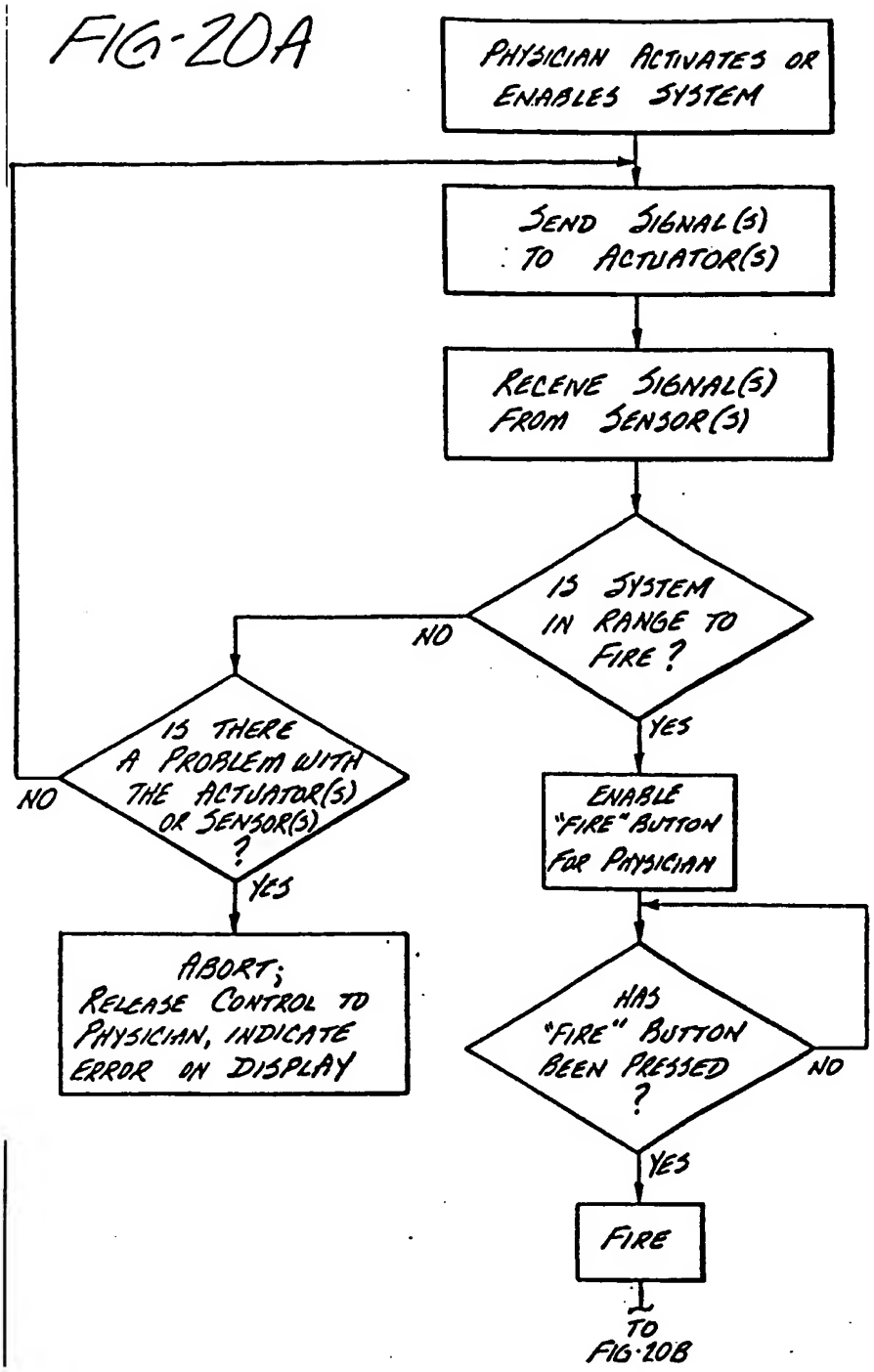
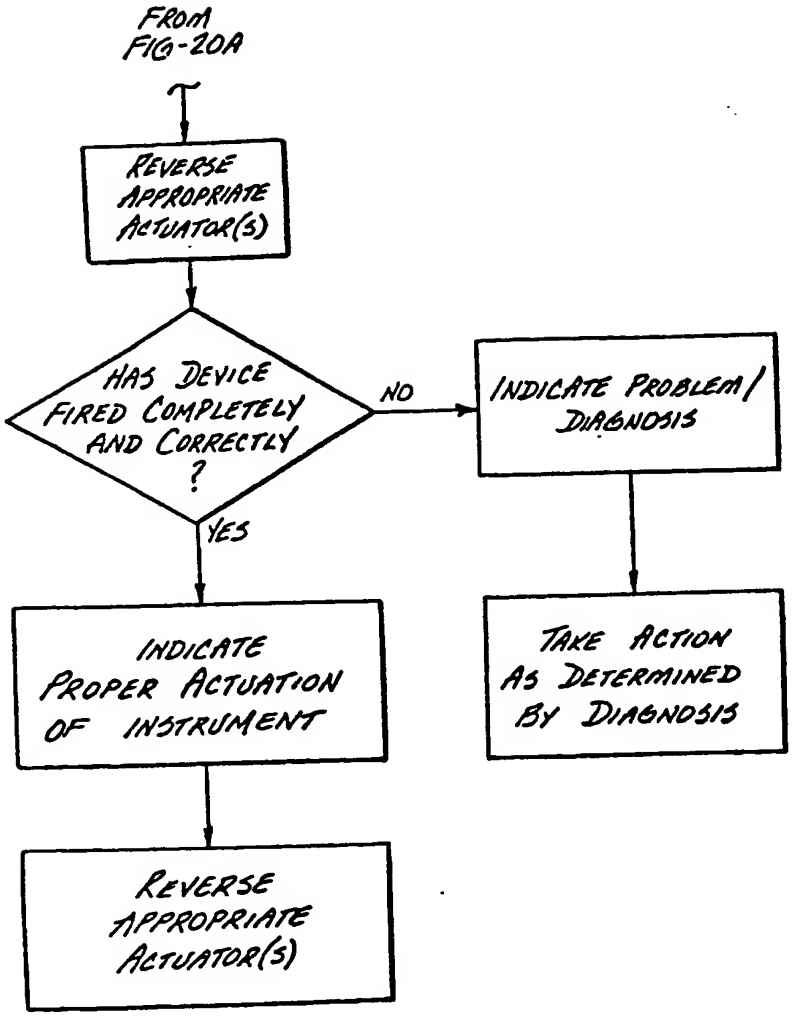

PHYSICIAN ACTIVATES OR ENABLES SYSTEM
SEND SIGNAL(S) TO ACTUATOR(S)
RECEIVE SIGNAL(S) FROM SENSOR(S)
IS SYSTEM IN RANGE TO FIRE ?
NO
YES
IS THERE A PROBLEM WITH THE ACTUATOR(S) OR SENSOR(S) ?
NO
YES
ENABLE "FIRE" BUTTON FOR PHYSICIAN
ABORT; RELEASE CONTROL TO PHYSICIAN, INDICATE ERROR ON DISPLAY
HAS "FIRE" BUTTON BEEN PRESSED ?
NO
YES
FIRE
TO FIG·20B

FIG-20B


FROM FIG-20A
REVERSE APPROPRIATE ACTUATOR(S)
HAS DEVICE FIRED COMPLETELY AND CORRECTLY ?
NO
INDICATE PROBLEM/ DIAGNOSIS
YES
INDICATE PROPER ACTUATION OF INSTRUMENT
TAKE ACTION AS DETERMINED BY DIAGNOSIS
REVERSE APPROPRIATE ACTUATOR(S)